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Industrial Waste Air Model (IWAIR) User's Guide

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Industrial Waste Air Model (IWAIR) User's Guide

Office of Solid Waste
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Acronyms and Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
BAF	Bioaccumulation factor
BCF	Bioconcentration factor
BOD	Biological oxygen demand
CAA	Clean Air Act
CalEPA	California Environmental Protection Agency
CAS	Chemical Abstract Service
COD	Chemical oxygen demand
CSF	Cancer slope factor
DCOM	Distributed component model
EPA	Environmental Protection Agency
HEAST	Health Effects Assessment Summary Tables
HQ	Hazard quotient
HSDB	Hazardous Substances Databank
IRIS	Integrated Risk Information System
ISCST3	Industrial Source Complex, Short-Term Model, Version 3
IWAIR	Industrial Waste Air Model
IWEM	Industrial Waste Management Evaluation Model
MLVSS	Mixed-liquor volatile suspended solids
MLSS	Mixed-liquor suspended solids
MRL	Minimum risk level
PAH	Polycyclic Aromatic Hydrocarbons
RfC	Reference concentration
REL	Reference exposure level
SCDM	Superfund Chemical Data Matrix
TOC	Total organic carbon
TSS	Total suspended solids
WMU	Waste management unit

1.0 Introduction

This document describes how to use the Industrial Waste Air Model (IWAIR). A companion document, the *Industrial Waste Air Model Technical Background Document*, provides technical background information. This section of the User's Guide provides an overview of IWAIR, its purpose, operation, and application; describes the three major components of the system—the emissions, dispersion, and results models; and provides an overview of the remainder of the User's Guide.

1.1 Guide for Industrial Waste Management and IWAIR

The U.S. Environmental Protection Agency (EPA) and representatives from 12 state environmental agencies developed a voluntary *Guide for Industrial Waste Management* (hereafter, the *Guide*) to recommend a baseline of protective design and operating practices to manage nonhazardous industrial waste throughout the country. The guidance is designed for facility managers, regulatory agency staff, and the public, and it reflects four underlying objectives:

- Adopt a multimedia approach to protect human health and the environment;
- Tailor management practices to risk in the enormously diverse universe of waste, using the innovative, user-friendly modeling tools provided in the *Guide;*
- Reaffirm state and tribal leadership in ensuring protective industrial waste management, and use the *Guide* to complement state and tribal programs;
- Foster partnerships among facility managers, the public, and regulatory agencies.

The *Guide* recommends best management practices and key factors to consider to protect groundwater, surface water, and ambient air quality in siting, operating, and designing waste management units (WMUs); monitoring WMUs' impact on the environment; determining necessary corrective action; closing WMUs; and providing postclosure care. In particular, the guidance recommends risk-based approaches to choosing liner systems and waste application rates for groundwater protection and to evaluating the need for air controls. The CD-ROM version of the *Guide* includes user-friendly air and groundwater models to conduct these risk evaluations.

Chapter 5 of the *Guide*, entitled "Protecting Air Quality," highlights several key recommendations:

- Adopt controls to minimize particulate emissions.

- Determine whether WMUs at a facility are addressed by Clean Air Act (CAA) requirements and comply with those requirements.

- If WMUs are not specifically addressed by CAA requirements, use IWAIR to assess risks associated with volatile air emissions from units.

- Implement pollution prevention programs, treatment measures, or emissions controls to reduce volatile air emission risks.

EPA developed IWAIR and this User's Guide to accompany the *Guide* to evaluate inhalation risks. Workers and residents in the vicinity of a unit may be exposed to volatile chemicals from the unit in the air they breathe. Exposure to some of these chemicals at sufficient concentrations may cause a variety of cancer and noncancer health effects (such as developmental effects in a fetus or neurological effects in an adult). With a limited amount of site-specific information, IWAIR can estimate whether specific wastes or waste management practices may pose an unacceptable risk to human health.

1.2 Model Design

IWAIR is an interactive computer program with three main components: (1) an emission model to estimate release of constituents from WMUs; (2) a dispersion model to estimate fate and transport of constituents through the atmosphere and determine ambient air concentrations at specified receptor locations; and (3) a risk model to calculate either the risk to exposed individuals or waste constituent concentrations that can be protectively managed in the unit. The program requires only a limited amount of site-specific information, including facility location, WMU characteristics, waste characteristics, and receptor information. A brief description of each component follows. The *IWAIR Technical Background Document* contains a more detailed explanation of each.

1.2.1 Emission Model

The emission model uses waste characterization, WMU, and facility information to estimate emissions for 95 constituents (identified in Table 1-1) for four types of units: land application units, landfills, waste piles, and surface impoundments. You can also add chemical properties to model additional chemical constituents. The emission model selected for incorporation into IWAIR is EPA's CHEMDAT8 model. This model has undergone extensive review by both EPA and industry representatives and is publicly available from EPA's Web page (http://www.epa.gov/ttn/chief/software.html).

To facilitate emission modeling with CHEMDAT8, IWAIR prompts you to provide the required waste- and unit-specific data. Once you have entered these data, the model calculates and displays chemical-specific emission rates. If you decide not to develop or use the CHEMDAT8 rates, you can enter your own site-specific emission rates (g/m^2-s).

Table 1-1. Constituents Included in IWAIR

CAS Number	Compound Name	CAS Number	Compound Name
75070	Acetaldehyde	67721	Hexachloroethane
67641	Acetone	78591	Isophorone
75058	Acetonitrile	7439976	Mercury*
107028	Acrolein	67561	Methanol
79061	Acrylamide	110496	Methoxyethanol acetate, 2-
79107	Acrylic acid	109864	Methoxyethanol, 2-
107131	Acrylonitrile	74839	Methyl bromide
107051	Allyl chloride	74873	Methyl chloride
62533	Aniline	78933	Methyl ethyl ketone
71432	Benzene	108101	Methyl isobutyl ketone
92875	Benzidine	80626	Methyl methacrylate
50328	Benzo(a)pyrene	1634044	Methyl tert-butyl ether
75274	Bromodichloromethane	56495	Methylcholanthrene, 3-
106990	Butadiene, 1,3-	75092	Methylene chloride
75150	Carbon disulfide	68122	N,N-Dimethyl formamide
56235	Carbon tetrachloride	91203	Naphthalene
108907	Chlorobenzene	110543	n-Hexane
124481	Chlorodibromomethane	98953	Nitrobenzene
67663	Chloroform	79469	Nitropropane, 2-
95578	Chlorophenol, 2-	55185	N-Nitrosodiethylamine
126998	Chloroprene	924163	N-Nitrosodi-n-butylamine
10061015	cis-1,3-Dichloropropylene	930552	N-Nitrosopyrrolidine
1319773	Cresols (total)	95501	o-Dichlorobenzene
98828	Cumene	95534	o-Toluidine
108930	Cyclohexanol	106467	p-Dichlorobenzene
96128	Dibromo-3-chloropropane, 1,2-	108952	Phenol
75718	Dichlorodifluoromethane	85449	Phthalic anhydride
107062	Dichloroethane, 1,2-	75569	Propylene oxide
75354	Dichloroethylene, 1,1-	110861	Pyridine
78875	Dichloropropane, 1,2 -	100425	Styrene
57976	Dimethylbenz[a]anthracene, 7,12-	1746016	TCDD, 2,3,7,8 -
95658	Dimethylphenol, 3,4-	630206	Tetrachloroethane, 1,1,1,2-
121142	Dinitrotoluene, 2,4-	79345	Tetrachloroethane, 1,1,2,2-
123911	Dioxane, 1,4-	127184	Tetrachloroethylene
122667	Diphenylhydrazine, 1,2-	108883	Toluene
106898	Epichlorohydrin	10061026	trans-1,3-Dichloropropylene
106887	Epoxybutane, 1,2-	75252	Tribromomethane
111159	Ethoxyethanol acetate, 2-	76131	Trichloro-1,2,2-trifluoroethane, 1,1,2-
110805	Ethoxyethanol, 2-	120821	Trichlorobenzene, 1,2,4-
100414	Ethylbenzene	71556	Trichloroethane, 1,1,1-
106934	Ethylene dibromide	79005	Trichloroethane, 1,1,2-
107211	Ethylene glycol	79016	Trichloroethylene
75218	Ethylene oxide	75694	Trichlorofluoromethane
50000	Formaldehyde	121448	Triethylamine
98011	Furfural	108054	Vinyl acetate
87683	Hexachloro-1,3-butadiene	75014	Vinyl chloride
118741	Hexachlorobenzene	1330207	Xylenes
77474	Hexachlorocyclopentadiene		

*Chemical properties for both elemental and divalent forms of mercury are included.

1.2.2 Dispersion Model

IWAIR's second modeling component estimates dispersion of volatilized contaminants and determines air concentrations at specified receptor locations, using default dispersion factors developed with EPA's Industrial Source Complex, Short-Term Model, version 3 (ISCST3). ISCST3 was run to calculate dispersion for a standardized unit emission rate (1 $\mu g/m^2$- s) to obtain a dispersion factor, which is measured in $\mu g/m^3$ per $\mu g/m^2$ -s. The total air concentration estimates are then developed by IWAIR by multiplying the constituent-specific emission rates derived from CHEMDAT8 (or the rates you specified) with a site-specific dispersion factor. Running ISCST3 to develop a new dispersion factor for each location/WMU is time consuming and requires extensive meteorological data and technical expertise. Therefore, IWAIR incorporates default dispersion factors developed using ISCST3 for many separate scenarios designed to cover a broad range of unit characteristics, including

- 60 meteorological stations, chosen to represent the different climatic and geographical regions of the contiguous 48 states, Hawaii, Puerto Rico, and parts of Alaska;
- 4 unit types;
- 17 surface areas for landfills, land application units, and surface impoundments, and 11 surface areas and 7 heights for waste piles;
- 6 receptor distances from the unit (25, 50, 75, 150, 500, 1,000 meters);
- 16 directions in relation to the edge of the unit (only the one resulting in the maximum air concentration is used).

The default dispersion factors were derived by modeling each of these scenarios, then choosing as the default the maximum dispersion factor of the 16 directions for each WMU/surface area/height/meteorological station/receptor distance combination.

Based on the size and location of the unit you specify, IWAIR selects an appropriate dispersion factor from the default dispersion factors in the model. If you specify a unit surface area or height that falls between two of the sizes already modeled, an interpolation method will estimate dispersion in relation to the modeled unit sizes.

Alternatively, you may enter a site-specific dispersion factor developed by conducting independent modeling with ISCST3 or with a different model and proceed to the next step, the risk calculation.

1.2.3 Risk Model

The third component combines the constituent's air concentration with receptor exposure factors and toxicity benchmarks to calculate either the risk from concentrations managed in the unit or the allowable waste concentration (C_{waste}) in the unit that must not be exceeded to protect human health. In calculating either estimate, the model applies default values for exposure factors, including inhalation rate, body weight, exposure duration, and exposure frequency. These default values are based on data presented in EPA's *Exposure Factors Handbook* (U.S. EPA, 1997a) and represent average exposure conditions. IWAIR contains standard health benchmarks (cancer slope factors [CSFs] for carcinogens and reference concentrations [RfCs] for noncarcinogens) for 94 of the 95 constituents included in IWAIR.[1] These health benchmarks are obtained primarily from the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 2001, 1997b); for a complete list of sources, see Appendix B, Section B.2.2.3. IWAIR uses these data to estimate risk or hazard quotients (HQs) or to estimate allowable waste concentrations. You may override the IWAIR health benchmarks with your own values.

1.3 Overview of Approach to Estimating Risk or Allowable Concentration

Figure 1-1 provides an overview of the stepwise approach you will follow to estimate risk or allowable waste concentrations with IWAIR. The seven steps of the estimation process are shown down the right side of the figure, and the user input requirements are specified to the left of each step. As you provide input data, the program proceeds to the next step. Each step of the estimation process is summarized below (later sections of this User's Guide provide more detailed instructions):

1. **Select Calculation Method.** To begin, select one of two calculation methods—risk or allowable concentration. Use the risk calculation to arrive at chemical-specific and cumulative risk estimates; you must know the concentrations of constituents in the waste to use this option. Use the allowable concentration calculation method to estimate waste concentrations that may be managed protectively in new units.

2. **Identify Waste Management Unit.** Four WMU types can be modeled: surface impoundments, land application units, active landfills, and waste piles. For each WMU, you will be asked to specify some design and operating parameters, such as waste quantity, surface area, and depth for surface impoundments and landfills; height for waste piles; and tilling depth for land application units. The amount of unit-specific data needed as input will vary depending on whether you elect to have IWAIR calculate CHEMDAT8 emission rates or enter your own. IWAIR provides default values for several of the operating parameters that you may use, if appropriate.

[1] At the time IWAIR was released, no accepted health benchmark was available for 3,4-dimethylphenol from the hierarchy of sources used to populate the IWAIR health benchmark database, nor were data available from these sources to allow the development of a health benchmark with any confidence. In addition, IWAIR contains chemical properties for both elemental and divalent forms of mercury, but contains a health benchmark only for elemental mercury; no accepted benchmark was available for divalent mercury.

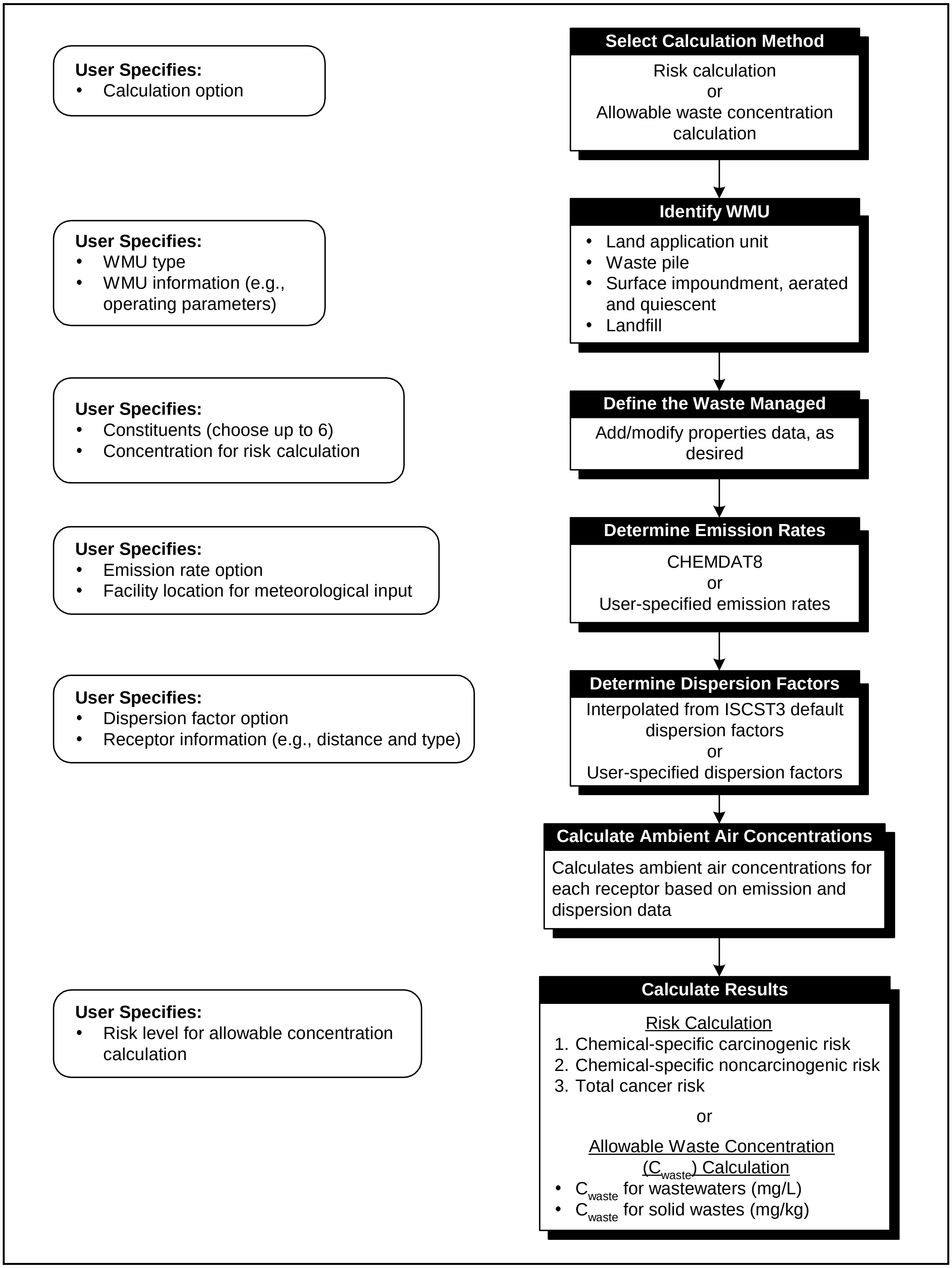

Figure 1-1. IWAIR approach for estimating risk or allowable waste concentrations. This figure shows the steps in the tool to assist you in developing risk or allowable waste concentration estimates.

3. **Define the Waste Managed.** If you choose to calculate chemical-specific risk estimates, specify constituents and concentrations in the waste. If you choose to calculate allowable waste concentrations, then specify only constituents of concern (no concentrations). You can also add chemicals or modify chemical property data in this step.

4. **Determine Emission Rates.** You can elect to develop CHEMDAT8 emission rates or provide your own site-specific emission rates for use in calculations. IWAIR will also ask for facility location information to link the facility's location to one of the 60 IWAIR meteorological stations. Data from the meteorological stations provide wind speed and temperature information needed to develop emission estimates. In some circumstances, you may already have emissions information from monitoring or from a previous modeling exercise. As an alternative to using the CHEMDAT8 rates, you may provide your own site-specific emission rates developed with a different model or based on emission measurements.

5. **Determine Dispersion Factors.** You can provide site-specific dispersion factors ($\mu g/m^3$ per $\mu g/m^2$-s) or have the model develop dispersion factors based on WMU information that you specify and the IWAIR default dispersion data. These dispersion factors are specific to the meteorological station selected. Because a number of assumptions were made in developing the IWAIR default dispersion data (for example, flat terrain was assumed), you may elect to provide site-specific dispersion factors that can be developed by conducting independent modeling with ISCST3 or with a different model. Whether you use IWAIR or provide dispersion factors from another source, specify distance to the receptor from the edge of the WMU, and the receptor type (i.e., resident or worker). These data are used to define points of exposure and exposure duration.

6. **Calculate Ambient Air Concentration.** For each receptor, the model combines emission rates and dispersion data to estimate ambient air concentrations for up to six waste constituents you have specified.

7. **Calculate Results.** The model calculates results by combining estimated ambient air concentrations at a specified exposure point with receptor exposure factors and toxicity benchmarks. Presentation of results depends on whether you chose to calculate risk or the allowable waste concentration.

   <u>Risk Calculation</u>: Results are estimates of cancer and noncancer risks from inhalation exposure to volatilized constituents in the waste. If risks are too high, your options are to (1) implement unit controls to reduce volatile air emissions; (2) implement pollution prevention programs or treatment measures to reduce volatile compound concentrations before the waste enters the unit; or (3) conduct a full, site-specific risk assessment to more precisely characterize risks from the unit.

Allowable Concentration Calculation: Results are estimates of constituent concentrations in waste that can be protectively managed in the unit so as not to exceed a defined risk level (e.g., 1E−6 or an HQ of 1) for specified receptors. This information should be used to determine preferred characteristics for wastes entering the unit. There are several options if it appears that planned waste concentrations may be too high: (1) implement pollution prevention programs or treatment measures to reduce volatile compound concentrations in the waste; (2) modify waste management practices to better control volatile compounds (for example, use closed tanks rather than surface impoundments); or (3) conduct a full site-specific risk assessment to more precisely characterize risks from the unit.

1.4 Capabilities and Appropriate Application of the Model

In many cases, IWAIR will provide a reasonable alternative to conducting a full-scale site-specific risk analysis to determine if a WMU poses unacceptable risk to human health. However, because the model can accommodate only a limited amount of site-specific information, it is important to understand its capabilities and recognize situations when it may be most appropriate to use in a specific way, when it may not be appropriate to use at all, or when another model would be a better choice.

Capabilities

- The model provides a reasonable, protective representation of volatile compound inhalation risks associated with WMUs.
- The model is easy to use and requires a minimal amount of data and expertise.
- The model is flexible and provides features to meet a variety of user needs.
- You can enter emission and/or dispersion factors derived from another model (perhaps to avoid some of the limitations below) and still use IWAIR to conduct a risk evaluation.
- The model can calculate risk from specified waste concentrations or allowable concentrations based on a target risk or HQ.
- You can modify health benchmarks and target risk level, when appropriate and in consultation with other stakeholders.
- You can add additional volatile organic chemicals to the 95 chemicals included with IWAIR.

<u>Appropriate Applications</u>

- *Release Mechanisms and Exposure Routes*. The model considers exposures from breathing ambient air. It does not address potential risks attributable to particulate releases, nor does it address risks associated with indirect routes of exposure (i.e, noninhalation routes of exposure). Appendix A discusses the potential for indirect risks. Additionally, in the absence of user-specified emission rates, volatile emission estimates are developed with CHEMDAT8 based on unit- and waste-specific data. The CHEMDAT8 model was developed to address only volatile emissions from WMUs. The model does not account for all competing removal mechanisms; specifically, runoff, erosion, and leaching are not modeled. In so much as these competing processes actually occur, the model would tend to slightly overestimate the volatile emissions.

- *Waste Management Practices*. Although you specify a number of unit-specific parameters that have a significant impact on the inhalation pathway (e.g., size, type, and location of WMU, which is important in identifying meteorological conditions), the model cannot accommodate information concerning control technologies, such as covers, that might influence the degree of volatilization (e.g., whether a waste pile is covered immediately after application of new waste). In this case, it may be necessary to generate site-specific emission rates and enter those into IWAIR. In addition, IWAIR cannot be used to estimate emissions from land application units using spray techniques for waste application; the emissions model component for land application units is only applicable to tilled land application units; again, in this case, it will be necessary to generate site-specific emission rates and enter them into IWAIR. IWAIR also cannot be used to model tanks; the surface impoundment component should *not* be used to model tanks, as most tanks have some height above the ground, and the dispersion factors used in IWAIR for surface impoundments are all for a ground-level source.

- *Terrain and Meteorological Conditions*. If a facility is located in an area of intermediate or complex terrain or with unusual meteorological conditions, it may be necessary to either generate site-specific air dispersion modeling results for the site and enter those results into the program, or use a site-specific risk modeling approach other than IWAIR. The model will inform you which of the 60 meteorological stations is used for a facility. If the local meteorological conditions are very different from the meteorological conditions at the site chosen by the model, it would be more accurate to choose a different model or enter a different location that results in the selection of a more appropriate meteorological station.

  The terrain type surrounding a facility can influence air dispersion modeling results and, ultimately, risk estimates. In performing air dispersion modeling to develop the IWAIR default dispersion factors, it was assumed that the facility was located in an area of flat terrain. The *Guideline on Air Quality Models* (U.S. EPA,

1993) can assist you in determining whether a facility is in an area of simple, intermediate, or complex terrain.

- *Receptor Type and Location*. IWAIR has predetermined worker and resident receptors and predetermined exposure factors. The program cannot be used to characterize risk for other possible exposure scenarios. The model contains dispersion factors for six receptor locations. IWAIR cannot evaluate other receptor locations unless you enter your own dispersion factors.

1.5 About This User's Guide

The focus of this User's Guide is to help you understand how to use IWAIR. The remainder of this document is organized into five sections and three appendices:

- Section 2, *Getting Started*, identifies system requirements for running IWAIR, provides stepwise guidance for installing the program, and introduces you to program screens and navigational tools (e.g., tabs, menus, and buttons). This section covers saving and retrieving data and printing reports. It also includes a troubleshooting guide.

- Section 3, *Selecting Calculation Method, WMU Type, and Modeling Pathway*, assists you in selecting the appropriate calculation method (i.e., calculation of risk estimates or calculation of allowable waste concentration), WMU type, and modeling pathway. This section describes the types of units IWAIR addresses.

  With both risk and allowable concentration calculations, you can select from the following four modeling pathways:

  — Pathway 1: Using CHEMDAT8 emission rates and ISCST3 default dispersion factors

  — Pathway 2: Using CHEMDAT8 emission rates and user-specified dispersion factors

  — Pathway 3: Using user-specified emission rates and ISCST3 default dispersion factors

  — Pathway 4: Using user-specified emission rates and dispersion factors.

  Depending on the calculation method, you will be directed to follow the detailed guidance provided in Section 4 for completing a risk calculation or in Section 5 for completing an allowable concentration calculation. Each of these sections provides pathway-specific guidance, as needed.

- Section 4, *Completing Risk/Hazard Quotient Calculations*, provides detailed guidance to develop risk estimates for wastes of known chemical concentration(s). Follow the screen-by-screen guidance to arrive at risk estimates.

- Section 5, *Completing Allowable Waste Concentration Calculations*, provides detailed guidance to predict allowable waste levels based on a user-specified risk level. Again, follow the screen-by-screen guidance to complete an allowable concentration calculation.

- Section 6, *Example Calculations*, provides a detailed example of how the program calculates air concentration and inhalation risk or allowable waste concentrations. It does not cover emission or dispersion calculations.

- Appendix A, *Considering Risks from Indirect Pathways*, describes the types of pathways by which an individual may be exposed to a contaminant, explains which pathways are accounted for in IWAIR, and discusses exposures unaccounted for in IWAIR.

- Appendix B, *Parameter Guidance*, describes and provides additional information on all parameter values needed to run IWAIR.

- Appendix C, *Physical-Chemical Property Values*, provides molecular weights and densities for IWAIR constituents.

A separate document, *Industrial Waste Air Model Technical Background Document*, provides detailed discussions on the CHEMDAT8 emission model, the ISCST3 model and modeling efforts conducted to develop the IWAIR default dispersion factors, and health benchmarks included in IWAIR.